

Available online at www.sciencedirect.com

ScienceDirect

Procedia - Social and Behavioral Sciences 152 (2014) 704 – 707

Procedia
Social and Behavioral Sciences

ERPA 2014

The effects of problem based approach on student's conceptual understanding in a university mathematics classroom

Yusuf Aydin^{a*}*^aIstanbul Commerce University, Mathematics Department, Istanbul, Turkey*

Abstract

Research studies in Education Faculties and various reports of the related branches of The Minister of National Education, and news of Social Media in Turkey call attention mainly to the educational problems of K-12 levels. The University Mathematics Classroom is almost a forgotten territory. We know that many university freshman students have insufficient backgrounds in mathematics and must take additional care to succeed at university level work. As we know, the success rate of freshman students in calculus is alarming. For many students to transit from high school mathematics to calculus is difficult. They are more comfortable with structured problems involving rote calculations. In calculus, conceptual understanding rather than manipulation of symbols is stressed. Freshman students resist making the transition to a more conceptual approach to mathematics. But in a Problem Based Learning Approach (PBLA), the real world problems assist students in this transition by providing physical examples of concepts to which they can relate to their major such as Business or Economy. By PBLA, we combined activities and problems with interactive lectures. The activities provided intensive treatment of a particular concept through student discovery and also gave students problem solving experience. Today a large number of universities are accepting students from a much wider range of academic backgrounds. The student readiness differs greatly in the first year's calculus classes. The calculus is often taught to the "middle or upper level of the class" leaving part of the class disengaged. The collaborative aspects of PBLA meet this challenge as students are provided a more customized teaching of calculus through personal interactions with group members and the instructor. PBLA is an effective means for teaching mathematical concepts which students generally enjoy working on the real world problems.

© 2014 The Authors. Published by Elsevier Ltd. This is an open access article under the CC BY-NC-ND license (<http://creativecommons.org/licenses/by-nc-nd/3.0/>).

Peer-review under responsibility of the Organizing Committee of the ERPA Congress 2014.

Keywords: Problem based learning approach; conceptual understanding; collaborative teaching; interactive teaching; calculus; functions; graphs

* Corresponding author. Tel. +90 212 444 0413/4630; fax : +90 212 320 9732

E-mail address: yaydin@ticaret.edu.tr

1. Introduction

After the establishment of mathematics education sections of education faculties in Turkey in 1982, the research on the problems of mathematics instruction at the K-12 level started. (Aydin, 1990 ;Aydin ,1990) .Despite the progress in the increase of the research on classroom instruction at the primary and secondary levels, very few research exists that examine mathematics teaching and learning at the university level. To understand the educational problems of university mathematics and to maintain student numbers of enrollment, standards in university, the research on the way of mathematics teaching and mathematics learning at the university level should also be carried out .This study explores the mathematics instruction at the university level in one of the calculus classroom about the concept of function in one of the universities in Turkey.

The concept of function is one of the most essential and fundamental concept in calculus. Students rarely develop an adequate understanding of it. (Dreyfus and Eisenberg, 1983; Even and Tirosh, 1995; Hacıömeroğlu, 2006) . The student's understanding of the concept of function is a complex process and difficult to understand. (Vinner and Dreyfus, 1989; Leinhardt, Zaslavsky, and Stein 1990).Students develop a good understanding of the function concept when they comprehend the knowledge of the concept of function and its relations to other concepts, and are able to use functions in different contexts . But, learning and being able to use functions in different contexts requires a long period of time of study (Hansson,2004)

Freshman students do not bring any appropriate concept image and concept definition of a function from high schools to university. Their knowledge of function is very weak or not existed at all. A majority of secondary students have memorized rules of functions and no reasoning of these rules or concepts. It is important for students to have a well-developed conceptual knowledge of functions, and to be successful in dealing with the concept of function in their career. In the job market, the demands for directly employable mathematical skills became important. Today, we know from the media that almost 85% of jobs need mathematical skills above the high school level. Students should learn mathematics to fit with their future employment needs. To attain the conceptual understanding of different concepts of mathematics, application of different methods of teaching, other than the lecture method, such as problem –based learning method, is required. Problem –based learning approach is an educational learning method which promotes students to find solution for real world problems into collaborative groups. Students learn with teacher guidance using real world problem situations related to their career.

Today a large number of universities are accepting students from a much wider range of academic backgrounds. The student readiness to university differs greatly in the first year calculus classes. The calculus is often taught to the “middle or upper level of the class” leaving part of the class disengaged. The weak students whose University Entrance Test Score (YGS) in mathematics four and able students whose YGS score fourth may be in the same calculus class. The collaborative aspects of Problem-Based Learning Approach (PBLA) meet this challenge as students are provided a more customized teaching of calculus through personal interactions with group members and the instructor, and the peer teaching. PBLA is an effective means for teaching mathematical concepts in calculus. Students generally enjoy working on the real world problems related to their majors. Before starting to teach functions, it is important to know the knowledge background of students. The hierarchical nature of mathematics, that is, the understanding of present topics depends on the understanding of previous topics, makes this starting point important. PBLA method allows instructor to find out the backgrounds of the students and decide the best starting point.

2. Method

The aim of this expository study is to find out the effects of problem based learning approach in a calculus class on student's academic achievement. The present study took place in realistic classroom setting with thirty freshman students in the 2013-2014 academic year, fall semester in Istanbul, Turkey . The variable function concept is investigated and studied where it is naturally occurred. We attempted to understand problems associated with learning processes of function concept with freshman mathematics classroom. In calculus, we start with preliminaries such as sets, numbers, plane, line equations, etc... The first main topic after preliminaries is functions. Before starting to teach functions, we applied a diagnostic test with a single question. “Define the Function and give an example of a relation which is not a Function.” Then we delivered the Function concept to the

students in the class as usual in a lecture mode of teaching during a week (3 hours), and give counter examples of a relation which is not a Function. We explained the Function concept through the Venn Diagrams and give several examples of a Function. As a homework, we assigned them to read the related pages from their text-book and solve the given exercises in their book. Then as a post-test, we asked the same question to the class to measure any gain of the concept of the Function. We evaluated and analyzed the answers. In the diagnostic test and in the post test we could not get any complete answer to the single question. We astonished with that complete failure and turned back and decided to apply PBLA method in our class which has an enrollment thirty students during a week time (3 hours) with activity sheets.

To teach mathematics at the university level, mainly, we have three options :

- Option 1: The traditional teaching approach. We present theory including proofs. Then we solve some examples to explain theory. It is applicable to any enrollment number of students in the class.
- Option 2: Weak theory approach. Theory is not emphasized. Theory is presented but is not learned consciously. Students learn by problem solving. We start with problems without any theory. We present procedural knowledge which includes the formal language of mathematics and algorithms for completing problems. It is applicable to any number of students' enrollment. If the class enrolment is around fifty, the teacher may be able to answer to questions from the floor and the students may encourage to ask questions.
- Option 3: Constructivist approach. Students construct and understand and apply theory in problem solving. Systematic linking of theory and problem solving occurs. Student's self-generated understandings and meanings take place. This option needs a class around thirty students. In such a class, instructor may be able to apply problem based collaborative teaching method with activity sheets.

After the failure of the application with the first option, we decided to apply the third option to achieve the mastery learning of Bloom for the function concept. We prepared Activity Sheets with problems related with their major or daily life, and allowed the students to study and solve the problems and answer the tasks in the activities with their neighbor's students. They formed informal groups as close sitting students to each other during the class time. To give an idea about our activity problems, the names and short description of some of them are as follows:

- Activity 1 : Binary Relation Concept: Fill the blank
 To each person, there corresponds?
 To each student, there corresponds?
 To each item in a supermarket, there corresponds?
 To each number, there corresponds its?
and so on .
- Activity 2: Univalence property. Sketch the correspondences in Activity1 by arrows i.e.geometric representations.
- Activity 3: Venn Diagrams .Sketch those correspondences by Venn Diagrams.
- Activity 8: Function and non-function. Determine which of the following equations specify function and non-function
- Activity 9: Vertical line test. Why it is or is not a function.
- Activity 10: Construct its function formula. Give a designed verbal problem to obtain its function as a formula
- Then we carry the following steps
 - a) classify those correspondences which will be function and non-function
 - b) arrive or construct the function concept
 - c) give the formal definition of a function etc..
- Then the following week , after immediately conducting the PBLA to the class , we ask the same question to the class ." Define the function. Give an example which is not a function." As a result , all of the students gave correct answer to this short test of five minutes. Mastery learning of Bloom accomplished for the concept of function.

3. Conclusion

PBLA with collaborative groups can help students to achieve to learn the function concept better than the traditional teaching method and make a successful transition to university mathematics study.

PBLA ended with a complete(mastery) learning of the function concept including weak students.

It helped to find out the starting point of students which is very important to know before the preparation of the lesson plan.

4. Discussion

One of the goals of this study was to find out the retention level of the definition of the function concept held by the university calculus classroom students at the beginning of their calculus courses. Unfortunately, high school graduates had no concept definition of a function before starting the calculus class. The function concept which is that of a correspondence between two nonempty sets that assigns to every element in the first set exactly one element in the second set is not retained with any of the students.

It seems that since University Entrance Examination in Turkey does not contain any concept test questions, like; define that mathematical concept, then students and school instruction do not give intense importance to the concept definitions in mathematics. Although, function concept is in the curriculum, it is not intensively taught.

The student's readiness differs greatly in the first year's calculus classes. This heterogeneously formed classroom needs a special care from the point of view of teaching. In most of the calculus classes in Turkey, lecture method is offered for the upper level of the classroom, leaving almost % 60 percent of the class disengaged. Since most of the time, the classes have an enrollment above fifty, there is no chance to apply some other teaching method for the instructor besides lecture method. Then the mastery learning does not take place at the crowded calculus classes.

On the other hand, demands for directly employable mathematical skills above the high school is important in the job market. To succeed in the job market makes the attainment of the conceptual understanding of every concept of calculus a necessity.

References

- Aydin, Y. (1990) Mathematics education , "Education and Science" , 14(75), 78-83
- Aydin, Y. (1990) Mathematics teacher preparation in Turkey today , " Educational Studies in Mathematics " , 21 , 471-478.
- Dreyfus, T. and Eisenberg, T. (1983) The Function concept in college students: linearity, smoothness and periodicity , "Focus on Learning Problems in Mathematics" , 5 -11.
- Even, R., and Tirosh, D. (1995) Subject-matter knowledge and knowledge about students as sources of teacher presentations of the subject matter, " Educational Studies in Mathematics " , 29 , 1-20.
- Haciomeroglu, G. (2006) " Prospective secondary teacher subject matter knowledge and pedagogical content knowledge of the concept of function" , Unpublished Dissertation, Florida State University .
- Hansson, O. (2004) " Preservice teachers view on the concept of function: A study including the utilization of concepts maps" , Unpublished dissertation, Lulea University of Technology.
- Leinhardt, G. ,Zavlasky, O. ,and Stein M. (1990) Functions, graphs , and graphing tasks : Learning and teaching , "Review of Educational Research " , 60 (1) 1-64.
- Vinner, S. , and Dreyfus, T. (1989) Images and definitions for the concept of function, " Journal for Research in Mathematics Education" , 20 (4) 356-366.